

Appendix II—Wetland Trend Data, Methods, and Results

The primary sources of information on the national status and trend in wetland acreage are five studies: An estimate of wetland extent in 1780 and 1980 by the Fish and Wildlife Service, two statistical estimates of wetland extent and change from 1954-74 and 1974-83 by the Fish and Wildlife Service, the 1982-1992 National Resources Inventory conducted by Natural Resources Conservation Service, and a compilation of State and Federal wetland estimates reported in 1996 (Dahl, 1990; Dahl and Johnson, 1991; Frayer, and others, 1983; Heimlich and Melanson, 1995; USDI-USGS, 1996). A third study by the U.S. Fish and Wildlife Service was released in draft as this report went to press, but is not included in the estimates derived here (Opheim, 1997). Most of these inventories (except Dahl, 1990, and USDI-USGS, 1996) produce estimates based on samples of wetland change at points or sample plots, with the plot or point acreage multiplied by a statistical expansion factor to represent remaining U.S. wetlands.

Unfortunately, more wetlands are generally inventoried at the early date of succeeding inventories in each of these multi-period survey efforts, although it is clear that U.S. wetland resources continue to be reduced. These inconsistencies result from changes in focus from waterfowl habitat to all wetlands, changes in wetland definition, differences in geographic scope, improvements in survey materials used by Fish and Wildlife Service technicians, and increasing knowledge and experience with wetlands by Natural Resources Conservation Service field technicians. Thus, inventories for 1954 done in 1954 and in the early 1980's resulted in an apparent increase in U.S. wetlands from 74.4 million acres of wetlands for waterfowl habitat to 108.1 million acres of all wetlands. The inventory for 1974 done using black and white photography in the early 1980's shows 99 million acres, but use of better infrared photography in inventories done in the late 1980's show an increase in wetlands to 105.9 million acres, resulting in an adjustment of the earlier figure. Wetland acreage in 1982 was adjusted between the 1982 and 1992 National Resources Inventory inventories (excluding Federal wetlands), increasing from 78.4 million to 112.2 million acres. The 1780 wetland acreages, although based on a variety of sources with more or less credibility, raise questions in States where the

acreage of wetlands estimated in 1780 is less than the acreage inventoried in modern inventories.

Differences in coverage between National Wetland Status and Trends Analysis inventories conducted by the U.S. Fish and Wildlife Service and the National Resources Inventory, conducted by USDA's Natural Resources Conservation Service of the U.S. Department of Agriculture, result in differences in wetland inventory results. For example, the National Wetland Status and Trends Analysis inventories development in urban areas as "urban," while the National Resources Inventory includes development for rural transportation, housing, and industry in rural areas. Clearly, any attempt to develop a systematic, consistent picture of the change in U.S. wetland acreage from 1780 to 1992 using these data must entail some process of adjustments from the published data to account for differences in scope and changes in wetlands inventoried over time. Recognizing the problems of inconsistent inventory methods, Vice-President Gore's Clean Water Action plan calls for USDA and USDI to use common data and reference points in carrying out future wetland inventories (Gore, 1997).

The estimates reported here involve three adjustments:

- Adjusting 1780 estimates where they are lower than later inventories;
- Adding an estimate of Federal wetlands to the 1982 and 1992 National Resources Inventory data; and
- "Benchmarking" the level of wetlands to more recent, higher estimates so that the series shows the decline in wetlands over time.

Adjusting 1780 Estimates

First, estimated acreages in 1780 for States that are less than modern State acreage estimates are increased to the extent of hydric soils present in the State, adjusted for the ratio of State 1992 National Resources Inventory wetlands to 1992 National Resources Inventory wetlands on hydric soils. The rationale is that hydric soils retain evidence of soil development under anaerobic conditions typical of permanently or seasonally saturated soils. Hydric soils thus indicate past wetland conditions, even if their hydrology and vegetation has been altered to remove them from wetland status in the present. Adjusting for the ratio of total wetlands to wetlands

on hydric soils accounts for the fact that not all wetlands are inventoried as occurring on hydric soils, either because they are known to occur on nonhydric soils or because soil information is missing.

Comparison of Dahl's 1780 estimate with the 1954 estimates (adjusted below to total 115 million acres) shows more wetlands in 1954 than in 1780 in Georgia, Oregon, Idaho, and Vermont. Comparing Dahl's 1780 estimate with the 1992 National Resources Inventory (totaling 111.4 million acres) shows more wetlands in 1992 than 1780 in an additional five States: New York, Montana, Kansas, Utah, and New Hampshire (see appendix table 2).

A very conservative adjustment would be to replace the existing numbers in the four States with the hydric soils, increased by the ratio of total 1992 wetlands to 1992 wetlands on hydric soils, where this results in larger acreage. In the case of Oregon and Idaho, the existing 1780 estimate is larger than the adjusted hydric acreage. This adjustment results in a new 1780 total of 221.9 million acres, an increase of about 700,000 acres. A more liberal adjustment would be to replace all of the 1780 estimates in the States above with the adjusted hydric acreage, where larger. This results in a new 1780 total of 224.3 million acres, an increase of about 3.2 million acres. The more liberal adjustment for all States was used.

Adding Federal Wetlands to the 1992 National Resources Inventory

The second adjustment adds an estimate of Federal wetland acreage by State to National Resources Inventory estimates of non-Federal wetlands to make

Appendix table 2—Adjustment of 1780 wetland estimates, selected States

State	Dahl (1990) 1780	Adjusted 1954	NRI 1992	Adjusted 1780
	Thousand acres			
Georgia	6,843.2	7,928.2	6,646.2	7,211.1
New York	2,562.0	1,088.4	3,717.5	3,417.0
Oregon	2,262.0	2,265.0	902.9	2,262.0
Montana	1,147.0	359.4	1,256.3	2,184.6
Idaho	877.0	1,128.1	679.7	877.0
Kansas	841.0	488.1	915.1	1,000.7
Utah	802.0	722.5	1,069.0	833.9
Vermont	341.0	360.8	710.0	726.6
New Hampshire	220.0	182.2	476.1	599.4
Nine-State total	15,895.2	14,522.7	16,372.8	19,112.3

Numbers have been bolded for emphasis.
Source: ERS, USDA analyses of various data.

them more comparable with Fish and Wildlife Service National Wetland Status and Trends Analysis estimates of total wetland acreage. This adjustment was accomplished by dipping the point location of the northeast corner of each of the approximately 3,600 National Wetland Status and Trends Analysis sample plots into a geographic information system coverage of Federal land ownership (at a scale of 1:2,000,000) to estimate the proportion of points that are in Federal ownership. When expanded, this is a useable estimate of federally owned wetland acreage. Because of the checkerboard pattern of much Federal ownership in the West, which is not reflected in the small-scale geographic coverage, the acreage estimates in the 17 western States were halved to reflect that acreage in National Wetland Status and Trends Analysis plots occurring on Federal land is likely to include substantial acreages of private land. This procedure results in an estimated 12.5 million acres of Federal wetlands, which is remarkably consistent with an earlier estimate of Federal wetland acreage made by Dale Pierce, of the Fish and Wildlife Service (Heimlich and Langner, 1986).

Benchmarking to Recent Wetland Totals

The final adjustment is to benchmark all the modern estimates of wetland acreage to a single level, preserving the observed changes between inventories and rates of change over the inventory periods, but providing for a monotonic decrease in U.S. wetland acreage from 1780 to 1992. Because of differences between methods, both the most recent estimate from U.S. Geological Survey (1996), totaling 113.3 million acres, and the 1992 National Resources Inventory estimate (totaling 123.9 million acres) were used as benchmarks, providing a range of estimated wetland acreages for each inventory date (1954, 1974, 1982-3, and 1992).

Results of Adjustments

The results of all three adjustments are shown in appendix table 3. The first series has the liberal adjustment to 1780 estimates and is controlled by the 1996 U.S. Geological Survey acreage. In this series, wetland acreage declines from 224.4 million acres in 1780 to 113.3 million acres in 1992. The second series also has the liberal adjustment to 1780 estimates, but is controlled by the 1992 National Resources Inventory estimate, plus the estimated Federal wetlands acreage. Thus, the most recent estimate of U.S. wetlands ranges from 113.3 million to 123.9 million acres, which is 50 to 55 percent of 1780 wetlands.

Appendix table 3—Alternative adjusted historical statistics on wetlands

		1996 USGS high land controls ¹					1992 NRI + Federal controls ²				
Wetland		Adjusted	Adjusted	Adjusted	1982 NRI	1992 NRI	Adjusted	Ajusted	Adjusted	1982 NRI	1992 NRI
region	State	1780	1954	1974	+	+	1780	1954	1974	+	+
		FWS ³	NWSTA ⁴	NWSTA ⁵	Federal ²	Federal ²	FWS ³	NWSTA ⁴	NWSTA ⁵	Federal ²	Federal ²
Total		224,355.5	125,831.6	116,678.4	114,086.5	113,296.7	224,346.8	136,480.4	127,327.2	124,735.2	123,945.4
Central Plains (CP) wetland region:											
CP	KS	1,000.7	313.4	444.8	427.4	435.4	1,000.7	793.1	924.5	907.1	915.1
CP	NE	2,910.5	2,186.9	1,999.1	1,901.5	1,905.5	2,910.5	1,487.3	1,299.5	1,201.9	1,205.9
CP	OK	2,842.6	832.4	945.1	922.3	949.7	2,842.6	380.0	492.7	469.9	497.3
CP subtotal		6,753.8	3,332.8	3,389.1	3,251.2	3,290.6	6,753.8	2,660.5	2,716.8	2,578.9	2,618.3
Delta and Gulf (DL) wetland region:											
DL	AR	9,848.6	4,251.3	2,699.0	2,762.9	2,763.6	9,848.6	4,627.8	3,075.5	3,139.4	3,140.1
DL	LA	16,194.5	11,204.3	9,463.7	8,916.0	8,784.2	16,194.5	13,614.7	11,874.1	11,326.4	11,194.6
DL	MS	9,872.0	5,887.7	4,174.6	3,998.6	4,067.0	9,872.0	7,495.7	5,782.6	5,606.6	5,675.0
DL	TN	1,937.0	873.9	811.2	786.0	787.0	1,937.0	892.4	829.7	804.5	805.5
DL	TX	15,999.7	7,471.5	7,707.8	7,630.6	7,612.4	15,999.7	5,514.7	5,751.0	5,673.7	5,655.5
DL subtotal		53,851.8	29,688.7	24,856.3	24,094.1	24,014.2	53,851.8	32,145.3	27,312.9	26,550.7	26,470.8
Mountain (MT) wetland region:											
MT	AZ	931.0	469.6	579.4	579.4	600.0	931.0	100.7	210.5	210.5	231.1
MT	CO	2,000.0	1,010.0	1,015.0	1,002.4	1,000.0	2,000.0	701.0	706.0	693.4	691.0
MT	ID	877.0	381.8	390.5	391.1	385.7	877.0	921.9	930.6	931.2	925.8
MT	NV	487.4	340.9	243.2	238.5	236.4	487.4	430.4	332.7	328.0	325.9
MT	NM	720.0	474.6	481.3	481.3	481.9	720.0	76.7	83.4	83.4	84.0
MT	UT	833.9	594.9	593.2	577.7	558.0	833.9	1,284.0	1,282.3	1,266.8	1,247.1
MT	WY	2,000.0	1,244.7	1,250.6	1,250.6	1,250.0	2,000.0	926.4	932.3	932.3	931.7
MT subtotal		7,849.3	4,516.5	4,553.2	4,521.0	4,512.0	7,849.3	4,441.1	4,477.8	4,445.6	4,436.6
Midwest (MW) wetland subregion:											
MW	IL	8,212.0	1,435.9	1,281.8	1,289.2	1,254.5	8,212.0	1,542.3	1,388.2	1,395.6	1,360.9
MW	IN	5,600.0	816.4	811.6	815.3	813.0	5,600.0	772.2	767.4	771.1	768.8
MW	KY	1,566.0	613.7	635.0	639.5	650.0	1,566.0	410.6	431.9	436.4	446.9
MW	MI	11,200.0	6,465.1	6,327.5	6,315.2	6,244.4	11,200.0	7,675.2	7,537.6	7,525.3	7,454.5
MW	MN	15,070.0	11,713.1	11,048.4	10,726.5	10,700.0	15,070.0	12,751.1	12,086.4	11,764.5	11,738.0
MW	MO	4,844.0	593.0	626.9	627.0	643.0	4,844.0	935.4	969.3	969.4	985.4
MW	OH	5,000.0	470.9	497.0	502.7	482.8	5,000.0	925.3	951.4	957.1	937.2
MW	WI	9,800.0	5,501.4	5,390.6	5,382.4	5,331.4	9,800.0	6,716.3	6,605.5	6,597.3	6,546.3
MW subtotal		61,292.0	27,609.5	26,618.8	26,297.8	26,119.1	61,292.0	31,728.3	30,737.6	30,416.6	30,237.9

See notes at end of table.

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Appendix table 3—Alternative adjusted historical statistics on wetlands—Continued

		1996 USGS high land controls ¹					1992 NRI + Federal controls ²				
Wetland		Adjusted 1780	Adjusted 1954	Adjusted 1974	1982 NRI +	1992 NRI +	Adjusted 1780	Adjusted 1954	Adjusted 1974	1982 NRI +	1992 NRI +
region	State	FWS ²	NWSTA ³	NWSTA ⁴	Federal ²	Federal ²	FWS ³	NWSTA ⁴	NWSTA ⁵	Federal ²	Federal ²
Northeast (NE) wetland subregion:											
NE	CT	670.0	208.8	182.2	179.3	172.5	670.0	397.4	370.8	367.9	361.1
NE	DE	479.8	299.9	262.7	226.5	223.1	479.8	340.0	302.8	266.6	263.2
NE	ME	6,460.0	6,450.7	6,464.5	6,470.7	6,460.0	6,460.0	5,512.6	5,526.4	5,532.6	5,521.9
NE	MD	1,658.7	617.2	596.9	597.8	591.6	1,650.0	1,053.6	1,033.3	1,034.2	1,028.0
NE	MA	818.0	620.4	616.9	621.5	588.5	818.0	626.1	622.6	627.2	594.2
NE	NH	599.4	582.0	604.2	605.0	591.4	599.4	466.6	488.8	489.7	476.1
NE	NJ	1,500.0	960.2	933.9	934.6	916.0	1,500.0	744.3	718.0	718.7	700.1
NE	NY	3,417.0	2,391.7	2,418.0	2,419.4	2,400.0	3,417.0	3,709.2	3,735.5	3,736.9	3,717.5
NE	PA	1,127.0	415.5	423.2	422.2	404.0	1,127.0	959.3	967.0	966.0	947.8
NE	RI	102.7	69.6	69.4	69.4	65.2	102.7	100.5	100.3	100.3	96.1
NE	VT	726.6	367.0	370.7	371.6	364.5	726.6	712.5	716.2	717.1	710.0
NE	WV	134.0	97.4	102.0	102.8	102.0	134.0	94.6	99.2	100.0	99.2
	NE subtotal	17,693.2	13,080.3	13,044.5	13,020.8	12,878.8	17,684.5	14,716.7	14,680.9	14,657.2	14,515.2
Pacific (PA) wetland subregion:											
PA	CA	5,000.0	1,469.5	1,214.6	1,254.2	1,235.9	5,000.0	2,134.4	1,879.5	1,919.1	1,900.8
PA	OR	2,262.0	1,592.6	1,123.6	1,495.6	1,500.0	2,262.0	1,522.9	1,053.9	1,425.9	1,430.3
PA	WA	1,350.0	966.1	949.7	950.5	938.0	1,350.0	1,040.1	1,023.7	1,024.5	1,012.0
	PA subtotal	8,612.0	4,028.2	3,287.9	3,700.3	3,673.9	8,612.0	4,697.4	3,957.1	4,369.5	4,343.1
Prairie Pothole (PP) wetland subregion:											
PP	IA	4,000.0	497.1	416.5	420.0	421.9	4,000.0	1,257.9	1,177.3	1,180.8	1,182.7
PP	MT	2,184.6	499.9	824.1	823.5	840.3	2,184.6	1,022.2	1,346.4	1,345.9	1,362.7
PP	ND	4,927.5	2,523.3	2,637.6	2,505.4	2,490.0	4,927.5	3,858.0	3,972.3	3,840.1	3,824.7
PP	SD	2,735.1	2,101.9	1,779.2	1,771.8	1,780.0	2,735.1	2,466.0	2,143.3	2,135.9	2,144.1
	PP subtotal	13,847.2	5,622.2	5,657.4	5,520.7	5,532.2	13,847.2	8,604.2	8,639.4	8,502.7	8,514.2
Southeast (SE) wetland subregion:											
SE	AL	7,567.6	3,280.5	3,145.3	3,115.0	3,100.0	7,567.6	3,917.8	3,782.6	3,752.3	3,737.3
SE	FL	20,325.0	12,906.4	11,461.4	11,202.1	11,038.6	20,325.0	13,119.0	11,674.0	11,414.7	11,251.2
SE	GA	7,211.1	8,000.6	7,854.2	7,786.7	7,714.3	7,211.1	7,242.8	7,096.4	7,028.8	6,956.4
SE	NC	11,089.5	7,828.7	6,975.9	5,777.1	5,689.5	11,089.5	7,398.4	6,545.6	5,346.8	5,259.2
SE	SC	6,414.0	4,820.8	4,735.9	4,690.6	4,659.0	6,414.0	4,040.0	3,955.1	3,909.8	3,878.2
SE	VA	1,849.0	1,116.4	1,098.5	1,109.2	1,074.6	1,849.0	1,768.9	1,751.0	1,761.7	1,727.1
	SE subtotal	54,456.2	37,953.4	35,271.2	33,680.7	33,276.0	54,456.2	37,486.9	34,804.7	33,214.1	32,809.4

¹USDI-USGS (1996). ²Heimlich and Melanson (1995). ³Dahl (1990). ⁴Frayner, and others (1983). ⁵Dahl and Johnson (1991).
Source: ERS analysis of data from the studies cited above.